

---

# UNIVERSITI SAINS MALAYSIA

First Semester Examination  
Academic Session 2006/2007  
*Peperiksaan Semester Pertama  
Sidang Akademik 2006/2007*

Oktober/November 2006

## **EBP 103/3 - Polymer Organik Chemistry** ***EBP 103/3 - Kimia Organik Polimer***

Time : 3 hours  
*Masa : 3 jam*

---

Please ensure that this paper consists of ELEVEN printed pages before you proceed with the examination.

This paper contains SEVEN questions.

Answer any FIVE questions. If a candidate answers more than five questions, only the first five answers will be examined and awarded marks.

Answer to any question must start on a new page.

All questions could be answered in Bahasa Malaysia or English.

*Sila pastikan bahawa kertas peperiksaan ini mengandungi SEBELAS muka surat yang bercetak sebelum anda memulakan peperiksaan.*

*Kertas soalan ini mengandungi TUJUH soalan.*

*Jawab LIMA soalan. Jika calon menjawab lebih daripada lima soalan hanya lima soalan pertama mengikut susunan dalam skrip jawapan akan diberi markah.*

*Mulakan jawapan anda untuk setiap soalan pada muka surat yang baru.*

*Semua soalan boleh dijawab samada dalam Bahasa Malaysia atau Bahasa Inggeris.*

1. [a] Describe briefly the followings with specific example for each:

- (i) Elimination reaction
- (ii) Lewis base
- (iii) Polar interaction
- (iv) Inductive effects

(40 marks)

[b] Describe **TWO** of the following functional groups:

- (i) Effect of double bond on stereoregularity of polymer structure
- (ii) Interchain interaction in hydroxyl-containing polymer
- (iii) Nucleophilic substitution in carboxyl group

Give a specific example for each.

(60 marks)

1. [a] *Jelaskan secara ringkas beserta dengan contoh spesifik istilah-istilah berikut:*

- (i) *Tindakbalas penyingkiran*
- (ii) *Bes Lewis*
- (iii) *Interaksi berkutub*
- (iv) *Kesan induktif*

(40 markah)

[b] *Bincangkan 2 daripada kumpulan berfungsi yang berikut:*

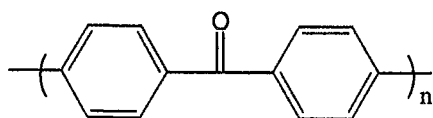
- (i) *kesan ikatan dubel terhadap keseragaman-stereo bagi struktur polimer*
- (ii) *interaksi antara-rantai bagi polimer berkumpulan fungsi hidroksi*
- (iii) *tindakbalas penukargantian nukleofilik bagi kumpulan karboksil*

*Berikan contoh spesifik bagi setiap satunya.*

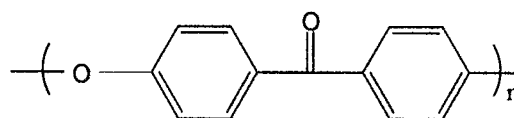
(60 markah)

2. Explain all of the followings:

[a] Level of crystallinity of polyketone (A) is higher than polyetherketone (B).



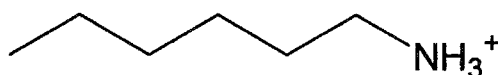
(A)



(B)

(25 marks)

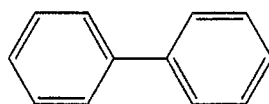
[b] Natural rubber is mainly hydrocarbon polymeric chain while carbon filler consist of various carbonyl, hydroxyl and carboxylic groups. Their mixing is improved with the presence of the surfactant shown in (C).



(C)

(25 marks)

[c] In gaseous phase, the biphenyl unit (D) is non-coplanar (torsional angle  $45^\circ$ ) but in aromatic polyetherketone the backbone subunit rings are coplanar.



(D)

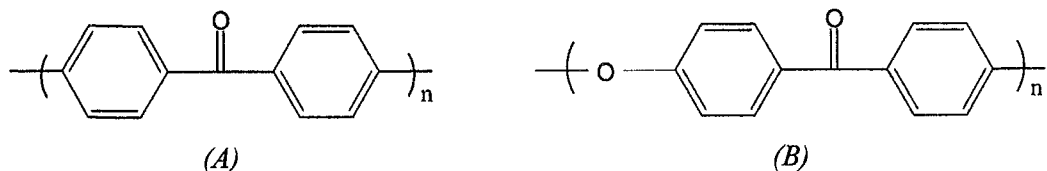
(25 marks)

[d] Except for the presence of functional group, Nylon 11 has similar structure with polyethylene. However the melting point of Nylon 11 is  $184 - 187^\circ\text{C}$  but polyethylene is  $130 - 134^\circ\text{C}$ .

(25 marks)

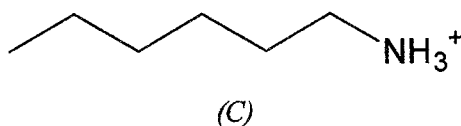
2. Huraikan semua pernyataan yang berikut:

[a] Tahap penghabluran bagi poliketon (A) adalah lebih tinggi dari polieterketon (B).



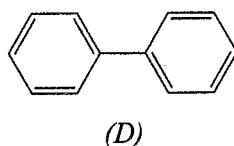
(25 markah)

[b] Getah asli keseluruhannya berupa rantai polimer hidrokarbon manakala pengisi karbon pula mengandungi kumpulan berfungsi karbonil, hidroksil, dan karboksilik. Percampuran antara mereka meningkat dengan kehadiran surfaktan (C).



(25 markah)

[c] Dalam fasa gas, struktur bifenil (D) adalah tidak ko-planar (sudut kilasan  $45^\circ$ ) tapi dalam struktur polieterketon aromatik, ianya adalah ko-planar.



(25 markah)

[d] Selain kehadiran kumpulan berfungsi, Nilon 11 mempunyai struktur yang sama dengan polietelina. Walaubagaimanapun, takat lebur nilon 11 adalah  $184 - 187^\circ\text{C}$  manakala polietelina adalah  $130 - 134^\circ\text{C}$ .

(25 markah)

3. [a] In Fourier Transform Infra-Red spectroscopy (FTIR) what is meant by infra-red active? Illustrate by giving an example.

(25 marks)

- [b] In Nuclear Magnetic Resonance spectroscopy (NMR), what is meant by chemical shift?

(25 marks)

- [c] Predict the structure of a polymer having repeating unit empirical formula  $C_5H_8O_2$  based on the given FTIR,  $^1H$ -NMR and  $^{13}C$  NMR spectroscopies.

(50 marks)

3. [a] *Di dalam spektroskopi Peralihan Fourier Infra-Merah(FTIR), apa yang dimaksudkan dengan infra-merah aktif. Perihal dengan menggunakan gambarajah yang sesuai.*

(25 markah)

- [b] *Di dalam spektroskopi Resonans Magnetic Nuclear, (NMR), apa yang dimaksudkan dengan anjakan kimia.*

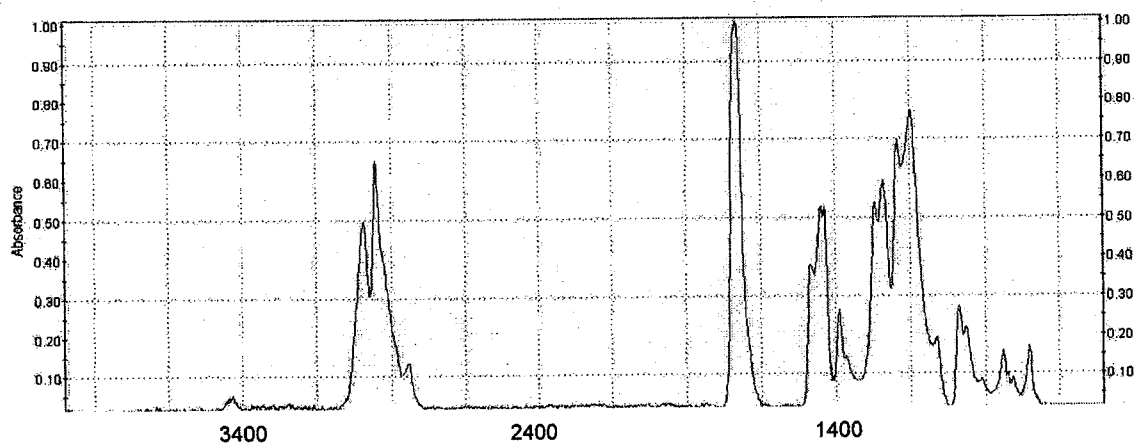
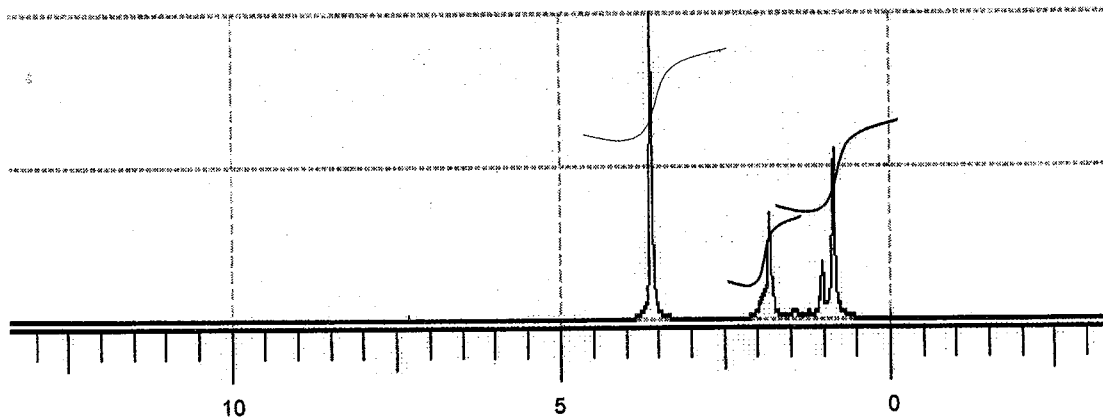
(25 markah)

- [c] *Ramalkan struktur polimer dengan formula empiris unit berulang sebagai  $C_5H_8O_2$  berdasarkan spektroskopi FTIR, H-NMR dan C-NMR yang diberi.*

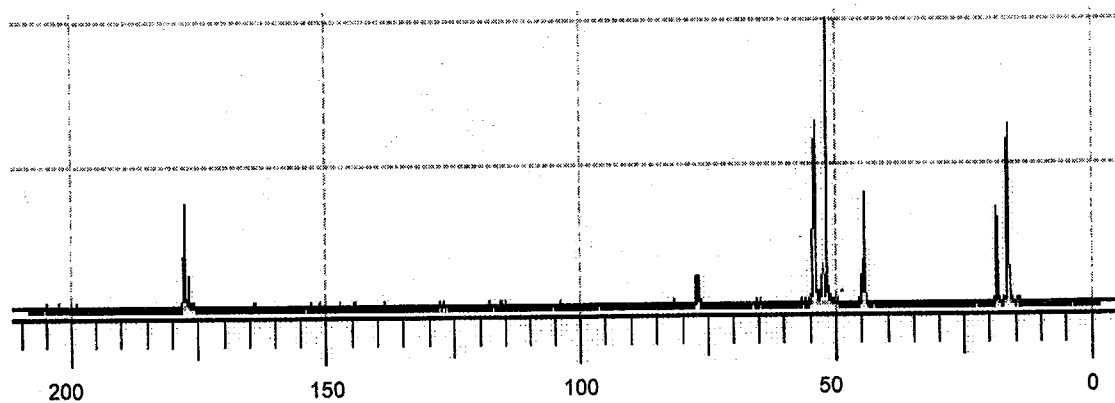
(50 markah)

- 6 -

FTIR

<sup>1</sup>H NMR

...6/-

<sup>13</sup>C NMR

...7/-

4. [a] Discuss aromaticity based on resonance stabilization, conformation and reactivity. Illustrate with specific examples. (50 marks)
- [b] Give the difference between step growth polymerization and chain growth polymerization. (20 marks)
- [c] Write the chemical reaction of the following:
- (i) prepolymer formation by the reaction of bisphenol A and epichlorohydrin. (10 marks)
  - (ii) polyamide 6 formation from lactam. (10 marks)
  - (iii) polyurethane formation from diisocyanate and diol (10 marks)
4. [a] *Bincangkan kearomatikan berdasarkan kestabilan resonans, konformasi dan kereaktifan. Jelaskan dengan mengambil contoh yang sesuai.* (50 markah)
- [b] *Berikan perbezaan antara pempolimeran langkah dan pempolimeran rantai.* (20 markah)
- [c] *Tuliskan tindakbalas kimia bagi berikut:*
- (i) *pembentukan prapolimer dengan tindakbalas bisfenol A dan epiklorohidrin* (10 markah)
  - (ii) *pembentukan poliamida 6 daripada laktam* (10 markah)
  - (iii) *pembentukan poliuretana daripada diisosianat dan diol* (10 markah)

5. [a] Explain the following typical radical producing reactions. Answer should be accompanied with example and its chemical reaction.

- (i) Thermal decomposition
- (ii) Photolysis
- (iii) Redox reaction
- (iv) Ionizing radiation

(20 marks)

- [b] Explain the following termination mechanism for polymer radicals.

- (i) Termination by combination of acrylonitrile macro-radicals.

(10 marks)

- (ii) Disproportionation of vinyl acetate macro-radicals.

(10 marks)

- [c] Write the following free radical polymerization mechanisms of methyl methacrylate.

- (i) Initiation by dicumyl peroxide

(20 marks)

- (ii) Propagation

(20 marks)

- (iii) Termination occurs at temperature above 333K

(20 marks)



5. [a] *Jelaskan tindakbalas pembentukan radikal yang tipikal seperti berikut. Jawapan perlu disertai dengan contoh dan tindakbalasnya.*

- (i) *penguraian terma*
- (ii) *fotolisis*
- (iii) *tindakbalas redoks*
- (iv) *penyinaran ion*

(20 markah)

- [b] *Jelaskan mekanisme penamatan bagi radikal polimer seperti berikut:*

- (i) *penamatan dengan gabungan bagi radikal makro akrilonitril.*

(10 markah)

- (ii) *disproporsionasi bagi radikal makro vinil asetat.*

(10 markah)

- [c] *Tuliskan mekanisme pempolimeran radikal bebas bagi metil metakrilat seperti berikut:*

- (i) *permulaan dengan dikumul peroksida*

(20 markah)

- (ii) *perambatan*

(20 markah)

- (iii) *penamatan berlaku pada suhu melebihi 333K*

(20 markah)

6. [a] Write the following cationic polymerization mechanism of isobutylene.
- (i) Initiation by  $\text{AlCl}_3$  and  $\text{CH}_3\text{Cl}$   
(20 marks)
  - (ii) Propagation  
(20 marks)
  - (iii) Termination by a uni-molecular rearrangement of the ion pairs.  
(20 marks)
- [b] Describe the polymerization mechanisms of styrene initiated by sodium naphthalene. Discussion should be accompanied with chemical reactions.  
(40 marks)
6. [a] *Tuliskan mekanisme pempolimeran kationik bagi isobutilena seperti berikut:*
- (i) *permulaan dengan  $\text{AlCl}_3$  dan  $\text{CH}_3\text{Cl}$*   
(20 markah)
  - (ii) *perambatan*  
(20 markah)
  - (iii) *penamatan dengan penyusunan semula uni-molekul bagi pasangan ion*  
(20 markah)
- [b] *Huraikan mekanisme pempolimeran bagi stirena yang dimulakan dengan natrium naftalena. Perbincangan perlu disertai dengan tindakbalas kimia.*  
(40 markah)

7. [a] Discuss the initiation, propagation and termination mechanism for polymerization of styrene in liquid ammonia, with potassium amide as initiator.
- (60 marks)

- [b] Write the step growth polymerization reaction of the following polymers:

- (i) Polyamide 6,6
- (ii) Polycarbonate
- (iii) Poly(ethylene terephthalate)
- (iv) Novolac

(40 marks)

7. [a] *Bincangkan mekanisme pemulaan, perambatan dan penamatan bagi pempolimeran stirena di dalam ammonia cecair dan kalium amida sebagai pemula.*

(60 markah)

- [b] *Tuliskan tindakbalas pempolimeran langkah bagi polimer seperti berikut:*

- (i) *poliamida 6,6*
- (ii) *polikarbonat*
- (iii) *poli(etilena tereftalat)*
- (iv) *novolak*

(40 markah)